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## CIRCULAR TUBULAR HEAT PIPE HAVING A SEALED STRUCTURE CLOSING A DISTAL OPENING THEREOF

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention:

5 The present invention relates to a circular tubular heat pipe having a sealed structure closing a distal opening thereof and, more particularly, to a heat pipe having a sealed structure without using a shrinking process for reducing a diameter of the distal opening.

#### 2. Description of the Related Art:

10 Whether the performance of an electronic product is good enough depends on its operating velocity, and the problem of heat dissipation of an electronic element in the electronic product is the major influence on operating velocity.

15 For example, a CPU (central processing unit) on a mother board of a computer is in charge of command and signal transmission as well as program and numerical calculation, which provide a very fast frequency to the CPU and produce high temperatures that further influence the electronic property of the CPU. As a result, the operating velocity slows down or the CPU may even stops working. Therefore, a 20 heat dissipation device is mounted on the CPU to maintain a proper working temperature and avoid the CPU stopping work because of overheating.

25 To improve the heat dissipation function of the heat dissipation device, the heat dissipation device comprises a heat pipe with high conductive efficiency and able to absorb and dissipate heat repeatedly.

The heat pipe has a tubular body. The tubular body has two ends. One is a closed end and the other is a distal opening. After a capillary material is inserted into the tubular body and a working fluid is charged into the tubular body, the distal opening is sealed to complete the manufacturing  
5 of the heat pipe.

When one end (the hot end) of the heat pipe contacts an electronic element that generates heat, the working fluid in the form of a liquid is heated and evaporates. The evaporated working fluid flows through a closed channel inside the tubular body to the other end (the cool end) of the heat pipe, where condenses to become liquid again. The working fluid is absorbed by the capillary material and return to the hot end. In this way, the heat pipe becomes a heat dissipation element having recyclable working fluid therein, and thus improves the heat dissipation efficiency and maintains an average temperature for the  
10 electronic element. To ensure that a heat pipe has a regular quality and function, the distal opening of the heat pipe has to be welded so as to  
15 seal it.

FIG. 1 shows a circular tubular heat pipe having a sealed structure formed thereon. The heat pipe has two ends. One is a closed end 24, and the other one is a distal opening 25. A diameter of the distal opening 25 is reduced to form a shrinked portion 21 by a shrinking process. Then the shrinked portion 21 is clamped to form a pressed portion 22. Then the distal opening 25 is welded to form a weld portion 23 to become a permanent sealed structure 2.

25 According to the aforesaid heat pipe having a sealed structure,

the main purpose of the shrunk portion is to reduce the volume and area of the distal opening for facilitating the welding process. However, the capillary material exposing out of the distal opening is unstable after the shrinking process, and the charge of working fluid has to be  
5 done by a manual process, which wastes time and increases cost. Inserting the capillary material and injecting the working fluid after the heat pipe is shrunk is also difficult and will increase the manufacturing steps and cost. Furthermore, when sealing a heat pipe with large dimensions, a large area and long welding path have to be  
10 welded. A special welding machine is required, which is expensive, as well as a very serious welding technology. Otherwise, it will take a very long time to complete the welding process. Because the heat pipe has a high heat conductive property, the welding circuit is large, and the welding time is long, heat will be conducted to the welding machine and  
15 molds and damage them.

Therefore, it is desirable to provide a heat pipe having a sealed structure closing a distal opening thereof that eliminates the aforesaid drawbacks.

#### SUMMARY OF THE INVENTION

20 The present invention has been accomplished under the circumstances in view.

It is the main object of the present invention to provide a circular tubular heat pipe having a sealed structure closing a distal opening thereof, which reduces an area of a sealed welding portion of  
25 the heat pipe, shortens the welding time and, in particular, can be

applied to a heat pipe with a large diameter of the distal opening .

It is another object of the present invention to provide a circular tubular heat pipe having a sealed structure closing a distal opening thereof, which eliminates the shrinking process of the distal opening of  
5 the heat pipe so as to reduce the cost.

It is still another object of the present invention to provide a circular tubular heat pipe having a sealed structure closing a distal opening thereof, which facilitates the pretreatment of the heat pipe, such as simplifying and accelerating the insertion of the capillary  
10 material and the charge of working fluid so as to improve the stability of the functions and quality of the heat pipe.

According to the present invention, the circular tubular heat pipe has a sealed structure closing a distal opening thereof. The improvement of the sealed structure comprises a concave wall portion  
15 formed on the heat pipe adjacent to the distal opening. A pressed recess portion is formed on the concave wall portion adjacent to the distal opening, the heat pipe being formed to have a overlapping wall at the pressed recess portion. A volume reduced portion is formed on the pressed recess portion adjacent to the distal opening, and a sealed  
20 welding portion formed on the volume reduced portion at the distal opening, thereby reducing an area of the sealed welding portion. As the formation of the pressed recess portion and the volume reduced portion reduces the area of the sealed welding portion, the shrinking process is eliminated, and the welding time of the heat pipe with a large diameter  
25 is shortened.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed 5 description, when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic top view of a heat pipe according to the prior art;

10 FIG. 2 is a perspective view of the present invention;

FIG. 3 is an upper cross-sectional view of the present invention shown the heat pipe being pressed to form a pressed recess portion;

15 FIG. 4 is a front longitudinal-sectional view of the present invention shown the heat pipe being pressed to form a pressed recess portion;

FIG. 5 is a perspective view of the present invention shown the heat pipe having a pressed recess portion.;

FIG. 6 is an upper view of the present invention shown the heat pipe being pinched to form a volume reduced portion.;

20 FIG. 7 is a schematic plain view of the present invention;

FIG. 8 is a cross-sectional view shown the circular tubular wall of the heat pipe of the present invention;

FIG. 9 is a cross-sectional view of one embodiment of the pressed recess portion of the heat pipe of the present invention;

25 FIG. 10 is a cross-sectional view of one embodiment of the volume reduced portion of the heat pipe of the present invention;

FIG. 11 is a cross-sectional view of another embodiment of the pressed recess portion of the heat pipe of the present invention;

FIG. 12 is a cross-sectional view of a further embodiment of the pressed recess portion of the heat pipe of the present invention;

5 FIG. 13 is a cross-sectional view of another embodiment of the volume reduced portion of the heat pipe of the present invention;

FIG. 14 is a cross-sectional view of a further embodiment of the volume reduced portion of the heat pipe of the present invention; and

10 FIG. 15 is a perspective view of the present invention shown the distal opening being further welded.

#### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

Referring to FIG. 2, a circular tubular heat pipe having a sealed structure closing a distal opening 15 thereof in accordance with the present invention is shown. A method for fabricating the sealed 15 structure comprises:

Step 1: pressing a region of the heat pipe adjacent to the distal opening 15 to pinch a circular tubular pipe formed an overlapping wall thereof.

Referring to FIG. 3 and FIG. 4, placing the distal opening 15 of 20 the heat pipe to a press mold set including an upper mold 16 and a lower mold 17. A region of the heat pipe adjacent to the distal opening 15 is pressed to form a concave wall portion 12 as shown in FIG. 5. A pressed recess portion 13 is formed on the concave wall portion 12 adjacent to the distal opening 15. The heat pipe is formed to have a overlapping 25 wall at the pressed recess portion 13. A pair of wing portions 18 is

formed on the pressed recess portion 13 adjacent to the distal opening 15. The pressed recess portion 13 can be further spot welded or ultrasonic welded when formed in the press mold set to improve an airtight quality and for facilitating a further sealing step.

- 5           Step 2: pinching the distal opening 15 of the heat pipe to reduce a dimension thereof.

Referring to FIG. 6 to FIG. 10, after pressing by the press mold set, the pair of wing portions 18 is pinched by a press machine 19 to form a volume reduced portion 14 on the pressed recess portion 13 adjacent to the distal opening 15.

By using the above method, the heat pipe can be formed to have a sealed structure 1 having a concave wall portion 12, a pressed recess portion 13, a pair of wing portions 18, and a volume reduced portion 14. The concave wall portion 12 is formed on a region of the heat pipe 15 adjacent to the distal opening 15. The pressed recess portion 13 is formed on the concave wall portion 12 adjacent to the distal opening 15. The heat pipe is formed to have a overlapping wall at the pressed recess portion 13 with a semi-circular, arched or V-shaped cross section respectively shown as FIG. 9, FIG. 11 or FIG. 12. The pair of wing 20 portions 18 is formed on the pressed recess portion 13 adjacent to the distal opening 15. The volume reduced portion 14 is formed on the pressed recess portion 13 adjacent to the distal opening 15 by further pinching the wing portions 18 and has a cross section of an ellipse, a pair of symmetric flat walls, or a curled shape respectively shown as 25 FIG. 10, FIG. 13 and FIG. 14.

Referring to FIG. 15, a sealed welding portion 151 having a reduced area is formed after pressing and pinching the region of the heat pipe adjacent to the distal opening 15 to form the pressed recess portion 13 and the volume reduced portion 14. Then a welding machine welds 5 the sealed welding portion 151 of the distal opening 15 of the volume reduced portion 14.

Instead of using the shrinking process of the prior art, the sealed structure of the heat pipe of the present invention is formed by first pressing a region of the heat pipe adjacent to the distal opening 15 10 to compact the inner wall, and then further pinching the distal opening 15 to reduce the dimension thereof, thereby centralizing and reducing a welding area of the distal opening 15 for facilitating further welding work and accelerating the sealing work to ensure that the sealing is in good quality. Because the circular tubular wall 11 retains an original 15 dimension before pressing and sealing, the pretreatment of the heat pipe, such as the insertion of the capillary material and the charge of the working fluid, can be done by an automatic mechanism to improve the stability of the heat pipe. For a heat pipe with a large diameter thereof, there exists problems such as a shrinking process, a very long welding 20 path, and a large welding area. By pressing the heat pipe to reduce the distal opening 15, not only is the welding time shortened, but also maintains the life of the machine and the molds.

As indicated above, the circular tubular heat pipe having a sealed structure with a closed distal opening thereof of the present 25 invention has the following advantages:

1. The formation of the pressed recess portion and the volume reduced portion reduces the area of the sealed welding portion of the heat pipe, shortens the welding time, and improves the production efficiency. Especially for the heat pipe with a large diameter, it can  
5 accelerate the welding process, and avoid the damage of the machine and molds caused by the heat of the welding.

2. Instead of using the shrinking process, the formation of the pressed recess portion and the volume reduced portion reduces the cost and improve the welding quality.

10 3. The formation of the pressed recess portion and the volume reduced portion retains the original dimension of the heat pipe before pressing and sealing for facilitating the pretreatment such as the insertion of the capillary material and the charge of the working fluid.

Although particular embodiments of the invention have been  
15 described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.